EXPERIMENTAL GRADING LINE FOR WASHING, SIZING, AND SORTING SWEETPOTATOES BEFORE STORAGE

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EXPERIMENTAL GRADING LINE FOR WASHING, SIZING, AND SORTING SWEETPOTATOES BEFORE STORAGE

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ABSTRACT

An experimental grading line capable of washing, sizing, and sorting sweetpotatoes before storage was assembled in 1972 and tested in a continuing effort to develop a system that will harvest in bulk and therefore simplify and speed up harvesting, provide an opportunity to sort clean roots under good working conditions, and permit sizing of roots mechanically instead of visually by workers. Field-graded roots were run over the grading line seven times and field-run roots one time at approximately weekly intervals through the harvest season. Washing with water under high pressure adequately cleaned the roots in the absence of brushes, which usually cause injury. In all runs, removal of jumbos, canners, and No. 2's increased the percentage of No. 1's considerably. After grading, not less than 87 percent of the roots met No. 1 grade specifications, and gains in storage space were 17 to 36 percent for field-graded roots and 45 percent for field-run roots. Under good curing conditions and after washing, sizing, and sorting, roots lost about the same amount of weight and were about as free of decay as roots placed directly under curing conditions. When curing conditions were bad, roots washed, sized, and sorted did not keep as well as untreated roots and were in poor condition after storage. Treating roots with hot water (125° F for 2½ minutes) was slightly detrimental to roots and was not necessary because black rot was not present. Chlorine in the dump washer (75 to 100 parts per million) or in the hot-water tank (30 to 50 parts per million) reduced losses from decay in two of three tests in which untreated roots did not keep well. In supplementary tests, the amount of root injury incurred on the experimental grading line was compared with that caused by a conventional grading line, and results showed that the experimental grading line caused less injury. Other test results showed that curing roots immediately after washing, sizing, and sorting for 4 days at 85° F kept weight losses reasonably low. A subjective evaluation of an entirely new grading line, built in 1973 for commercial operation, is also presented in this publication.

KEYWORDS: curing and storing sweetpotatoes, experimental grading line, washing, sizing, and sorting roots.

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INTRODUCTION

When sweetpotatoes are harvested in the fall, some are washed, graded, and shipped to market at once, but most are placed in storage just as they come from the field. The selection of sweetpotatoes for storage is done by workers who pick up the roots and place them in boxes after they are plowed out or by workers riding on a harvester as the roots pass them on a conveyor. Most workers are paid on a per-box basis, and all sweetpotatoes must be handled.

Usually, workers attempt to place sweetpotatoes larger than canning size and free of serious defects in one box and canning-size roots in another box. It is impractical to separate 1's, 2's, and jumbos from one another, although such separations were made when labor was plentiful and less expensive. Because of the separation required, the job of picking up is relatively slow and tedious. For this and other reasons, the accuracy attained in separation is poor compared with that desired. Storage operators often report that the quality of 30 percent, and sometimes up to 40 percent, of the roots in storage is not good enough for the fresh market. Because most of the costs of curing and storing sweetpotatoes apply, regardless of the quality or kind of roots stored, management should benefit by increasing the percentage of roots that produce the greatest profit, i.e., good quality No. 1 roots.

One way to overcome some of the variation in work done among workers in the field is to harvest with a riding harvester. With such equipment, the hills of sweetpotatoes are carried up to a horizontal conveyor where workers separate the roots from the vines, dirt, and one another in order to select the desired roots for placement in boxes. The roots not desired for storage move on the conveyor to the rear of the harvester and fall into a bulk box (or on the ground) that is emptied into a truck for transporting to a cannery. Each harvester usually covers 1 to 1½ acres per day (300 to 600 boxes, each with about 55 pounds of sweetpotatoes).

The accuracy of separation varies less from harvester to harvester than from worker to worker in the field, and it is affected by working conditions, supervision, and speed of harvesting. Because 50 to 75 percent of a crop is suitable for storage, the crews on harvesters must manually locate and remove well over half of all sweetpotatoes harvested. With the jostling of the harvester (often under dusty, windy conditions) and sometimes wet, heavy soil and vines mixed with roots (plus the necessity of pulling the roots off at the base of the vines), it is not surprising that the harvesting operation is relatively slow and sometimes not executed as well as desired.

Ideally, a grading line would be combined with a mechanical harvester and bulk-handling system that would deliver undamaged, ungraded roots to the grading area. The roots would be dug and separated from the soil, placed in bulk boxes or trucks, and transported to the grading line, with no attempt in the field at separating the roots according to quality. By making the separation on the grading line under reasonably static conditions, where small roots (canners) are mechanically sized out and large roots (jumbos) and those unsuitable for storage (mostly No. 2's) are sorted out, only about 15 to 30 percent of the crop would need to be handled manually. This estimate is obtained by assuming that a crop consists of 10 to 20 percent canners, 5 to 10 percent jumbos, and 10 to 20 percent No. 2's.

Besides permitting the separation of canners, jumbos, 2's, and presumably 1's for marketing, the grading line would provide clean roots for the selection of defective roots under conditions that provide two advantages. First, since the defective roots are removed (instead of good roots as on the harvester), any roots that are missed would not cause the good roots to fall into a lower, less valuable grade, and second, because successive workers at the sorting table would have a chance to improve upon prior selection, the degree to which defective roots are removed could be regulated reasonably well.

To simplify harvesting and improve the accuracy of separating roots according to quality and potential uses, an experimental grading line was assembled in 1972 for washing, sizing, and sorting sweetpotatoes before they are cured and stored. Because injury to the roots is undesirable, the units of this grading line were designed or modified to keep injury to a minimum. Also, because black-rot disease (*Ceratocystis fimbriata* Ell. & Halst.) is often spread in a dump tank and washer, a hot-water treatment was incorporated as a reasonable safe-

guard against this organism and as an aid in reducing soft rot (*2–5*).[4] Although proper curing will reduce black-rot infections, the degree of control from curing, if the organism is present, is not sufficient to prevent large losses. Investigators have reported some success in washing sweetpotatoes before storage (*7, 8*), but this treatment caused some losses from additional injury.

This report describes the equipment, experimental procedures, and test results for a new system of handling and processing sweetpotatoes that permits bulk harvesting and therefore simplifies and speeds up harvesting, allows sorting of clean roots under good working conditions, and permits sizing of roots mechanically. It also includes a description and subjective evaluation of a larger, modified, commercial grading line that was designed on the basis of results from testing the experimental grading line.

EQUIPMENT AND METHODS

Experimental Grading Line

The 3-foot-wide experimental grading line consisted of a water-dump washer, size grader, hand-sorting table, hot-water-treatment tank, and box-filling unit (fig. 1). Upon receipt from the field, the sweetpotatoes were poured from 1-bushel wirebound crates into about 350 gallons of water in the dump end of the dump washer. The roots were then swept to the live-roller conveyor by a trash pump that recirculated water from under the roller conveyor at about 300 gal/min and injected it through three ports into the dump tank behind the roots, which moved them away from the dump area.

As the roots traveled on the roller conveyor (40 ft/min), they passed under four rows of wash nozzles, each having four Teejet HSS 5008 nozzles rated to handle 1.55 gal/min at 150 lb/in^2. Water pressure of 110 to 120 lb/in^2 was obtained with a 5-hp gear pump operating off the waterline from a pond pump. Approximately 22 gal/min of water was put in at the washer, collected in the dump area, circulated several times to move the sweetpotatoes to the conveyor, and then discharged through an overflow pipe to remove soil held in suspension. The dump tank could also be rapidly flushed through a spring-loaded door in the bottom. The water source was a small pond about 100 feet from the grading line. Consequently, the water was not as free of contamination as purified city water.

From the washer, the sweetpotatoes passed over a short, rubberized belt and onto the sizing unit. The sizer had five V-shaped channels, with openings in the bottoms set at 1⅞ inches (*1*). Each channel side was formed with three round polyurethane belts (Molded Plastics Co., No. MP 1485) that traveled at different speeds to turn the roots into position to fall (if small enough) through the bottom. The lowest (sizing) belts traveled at 200 ft/min. The two upper belts on one side traveled at 100 ft/min, and the two upper belts on the opposite side traveled at 300 ft/min.

[4] Italic numbers in parentheses refer to items in "Literature Cited," page 18.

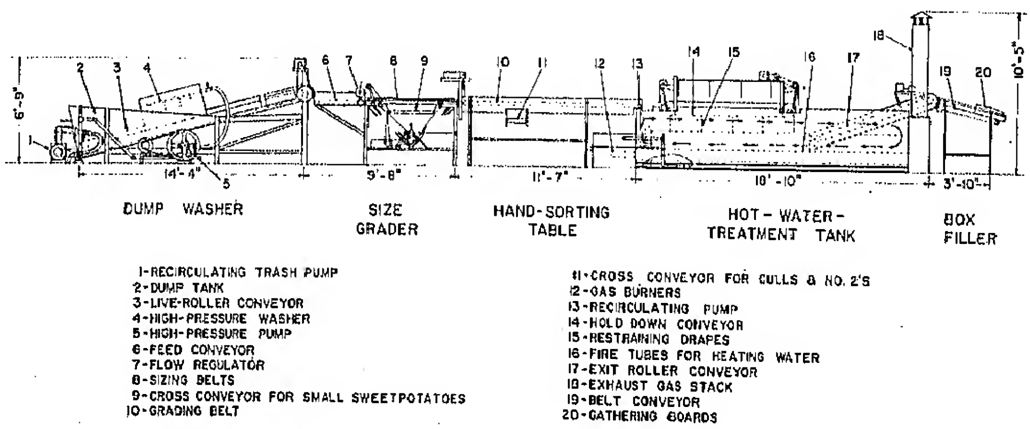

FIGURE 1.—Experimental grading line, 1972.

The sweetpotatoes retained by the size grader then passed to a rubberized belt where four workers removed defective roots, usually referred to as "pickouts," and then tossed them onto a rubberized cross conveyor mounted under the sorting belt. One worker then removed jumbo-size roots and placed them in boxes.

The sweetpotatoes fell from the sorting table into water at the front end of the hot-water-treatment tank (fig. 1). The water was heated to 125° F with three thermostatically controlled, gas-fired burners capable of producing a total of about 1,100,000 Btu/h. Hot combustion gases passed through three large tubes located beneath the sweetpotato-support bottom and extending the length of the tank. The water was circulated (about 1,500 gal/min) over the tubes by a propeller pump similar to that used in the dump area. Flow was directed above the sweetpotato-support bottom, from where the roots entered the tank, and toward the roller conveyor that elevated them out of the tank. With that much water movement, the sweetpotatoes would have been swept through the tank rapidly except for horizontal rod drapes that passed slowly through the tank on an overhead conveyor. The roots remained in the hot water about 2½ minutes.

The hot-water tank was originally designed for peaches, so galvanized-metal sheets were installed to reduce friction on the bottom where the roots were moved along by the water. Also, in the event of equipment failure, the tank was designed to drain hot water from the treating area into a collecting reservoir under the sweetpotato-support bottom to prevent prolonged exposure of the product to the hot water.

When conveyed out of the hot-water tank, the sweetpotatoes passed onto a rubberized belt equipped with a shunt, causing the roots to fall into wirebound boxes for subsequent storage or into corrugated cardboard boxes for shipment to market.

An accessory, a chlorinator with a booster pump, permitted chlorine injection into the high-pressure line feeding the washer or supplied chlorinated water at low pressure (and of high concentration) to the hot-water tank. The chlorine concentration was monitored with standard titration procedures and also by using chlorine test paper (La Motte Chemical Products Co., Chestertown, Md.). The chlorine treatment was added because it was the only treatment besides hot water that could be tested in this grading line without additional USDA and FDA approval. Preliminary tests indicated that chlorine could have some beneficial effect because of its effect on a wide range of decay-producing organisms and the fact that several fungi attack sweetpotatoes in storage.

Experimental Procedure

'Centennial' sweetpotatoes were plowed out, picked up, put into boxes, and run over the grading line on eight separate occasions at approximately weekly intervals through the harvest season of 1972. One of the eight runs was made with no attempt at separating roots in the field, i.e., field run. The other seven runs were made with field-graded roots, or with most of the canning-size roots left in the field. No attempt was made to determine how long the roots had been exposed in the field, but each of the eight runs was made on the day the roots were dug. A record was made of the time consumed in running the grading line, the number of boxes of canners sized out, the boxes of pickouts removed, the boxes of jumbos removed, and the boxes filled for storage or shipment.

During each run, 12 boxes of sweetpotatoes were taken from the grading line before they reached the dump washer (treatment A), 12 more boxes were filled with roots removed before they reached the hot-water tank (treatment B), and 12 boxes of roots were collected after they fell into boxes at the end of the line following the hot-water treatment (treatment C). When chlorine was added to the wash water (Cl–W), 12 boxes of roots were removed before reaching the hot-water tank to make the treatment comparable to treatment B. When chlorine was added to the hot-water tank (Cl–H), 12 boxes were removed after grading, as in treatment C. Chlorine treatments were made on October 10 (Cl–W at about 75 parts per million (p/m) chlorine); on October 26 (Cl–W at 75 to 100 p/m and Cl–H at 25 to 35 p/m); and on November 7 (Cl–W at 90 to 100 p/m and Cl–H at 35 to 50 p/m).

The 12 boxes from each treatment were randomly divided into 3 groups of 4 each. After recording the gross weight of boxes and roots,

four boxes from each treatment were stacked on one pallet and four on another. Then each pallet was filled with 24 additional boxes of roots from the end of the grader (treatment C), i.e., 6 boxes per layer in 4 layers. Both test pallets were placed in a commercial storage house. One test pallet was placed on the floor, an extra pallet of boxed roots was placed on top of it, and then the other test pallet was placed on top of the extra pallet.

The remaining four boxes from each treatment were covered with plastic to reduce desiccation and were transported about 30 miles to a small experimental storage house where they were held at 82° to 84° F and high relative humidity for 7 days. Then they were carefully transferred to a storage room that was ventilated to hold the temperature near 55° to 60° F. The curing temperature was maintained with thermostatically controlled, electric strip heaters mounted under a slatted floor. The relative humidity was maintained with a humidifier controlled by a Bahnson humidistat (Bahnson Co., Winston-Salem, N.C.) set at about 90 percent.

The roots in commercial storage remained in place until marketing. Temperature and relative humidity were controlled slightly by opening or closing doors to the four sections of the storage house, but outside weather conditions influenced temperature considerably because of the limited means of heating or cooling the stored roots. Each time a run was made, the test roots were placed with other roots going into storage. Therefore, each set of test roots was in a different location in the storage area but received the same treatment as the rest of the crop. Temperature and relative humidity were recorded with a hygrothermograph close to the top pallet. Early in the storage season the conditions in this top position were close to the recommended 85° F temperature and 85 to 90 percent relative humidity. As the weather became cooler, the temperature decreased to near 65° to 70° F for the first 5 days after the last harvest on November 7.

The test roots were stored until they were reached in the normal operation of removing for marketing. Most of the test roots were stored 2 to 3 months, but some were stored only 48 days and others as long as 182 days. When reached in storage, all test roots, from both commercial and experimental storage, were examined. The days of harvest in 1972 to respective dates of examination after storage were September 13–November 21, September 26–March 23 (1973), October 3–January 16 (1973), October 10–December 15, October 24–January 19 (1973), October 26–January 23 (1973), November 2–January 16 (1973), and November 7–December 19.

Each box was weighed, and the roots were separated (by number) into canning size (less than 1⅞ inches in diameter or less than 3 inches long); jumbo size (more than 3⅜ inches in diameter); No. 2 grade (defective because of scurf, circular spot, growth cracks, shape, length, or plow cuts; and all others (presumably of No. 1 quality at harvest). Those of presumably No. 1 quality were subdivided into seven groups as follows: (1) Roots with unsightly bruises, (2) roots with end rot, (3) roots with surface rot, (4) roots with Java black rot, (5) roots with other rots, (6) roots damaged (and usually decayed) by mice or rats, and (7) sound, reasonably attractive roots of acceptable quality. The classification was somewhat arbitrary but was as "tight" or tighter than we believe is customary for roots shipped to market. The classification of decaying roots was checked occasionally with personnel at the disease clinic operated by the Department of Plant Pathology at North Carolina State University, Raleigh. Although most of the root decay classified as end rot or surface rot was probably caused by *Fusarium* species, we are sure other fungi caused some of the decay. The same is true for Java black rot, which is caused by *Diplodia tubericola* (Ell. & Ev.) Taub. Other rots were tentatively identified as soft rot (*Rhizopus* sp.) or dry rot (*Diaporthe batatis* Harter and Field) but were usually considered as unidentifiable.

Field diseases such as scurf (*Monilochaetes infuscans* Ell. & Halst ex Harter) and circular spot (*Sclerotium rolfsii* Sacc.) were classified so as not to reflect any association of disease in the field with injury or inoculation on the grading line, i.e., the roots were classed as No. 2 grade on the assumption that the diseased roots should be removed as pickouts (if more than 15 percent of the root surface was covered with scurf or if circular spot lesions were detected).

The classification of roots was done by number to determine how many errors were made

by the sizer or by the workers in sorting, as well as how frequently roots were defective or became defective. Some of the data were converted to a weight basis by assuming that on the average jumbos, canners, No. 2's, and No. 1's weighed 1.5, 0.25, 0.5, and 0.5 pounds each, respectively. Admittedly, many canning-size roots weigh less than one-quarter of a pound, but those of good size are close to this weight.

In addition to the eight test runs described, a few supplementary tests were made. Two tests were designed to compare the amount of root injury incurred on the experimental grading line with that caused by a conventional grading line used for preparing roots for shipment to market. In one test, 'Jewel' sweetpotatoes with very tender skin, but with essentially no loss of skin, were selected in the field. Two bushels of these were marked with waterproof ink and dumped on each grading line along with several other boxes of sweetpotatoes. Most of the marked roots were recovered at the end of the grading lines, and 24 from each line, plus 24 carefully hand-washed roots, were displayed on a laboratory table. An additional 24 roots from each line and 24 hand-washed roots were cured for 4 days at 85° F and high relative humidity. All roots were displayed for 8 days and skin losses were estimated. Each root was weighed at appropriate intervals to record losses.

On several occasions, freshly harvested 'Jewel' or 'Centennial' sweetpotatoes were subjected to hot-water treatments at 5° intervals, from 115° to 140° F, for periods of 1, 2, 4, 6, 8, or 10 minutes. The roots were then cured for a week at 85° F and high relative humidity before being stored at 55° to 60° F for 4 months. After curing and at intervals during storage, the roots were examined for injury and development of decay. After storage, the roots were kept at 85° F for 7 weeks to induce sprouting, and the results were recorded.

Commercial Grading Line

In 1973, an entirely new grading line (slightly over 4 feet wide) was built for commercial operation (fig. 2). It consisted of a bulk-box dumper (fig. 3); a water-dump washer (fig. 4) with two live-roller conveyors (depth of roots and height of roller controlled speed of first conveyor, second conveyor spread roots out into single layer under high-pressure-spray washer); a short (length) sorting table for picking out trash and jumbo-size sweetpotatoes; a size grader capable of producing three sizes of canners (fig. 5); a sorting table for removing pickouts (2's, culls); and a reversible cross conveyor for filling bulk boxes (one-half ton)

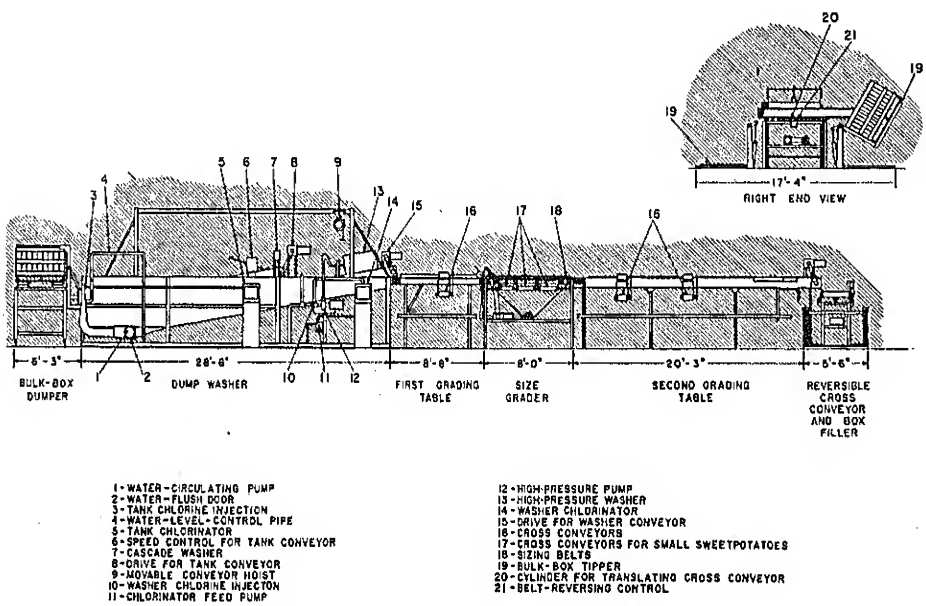

FIGURE 2.—Commercial grading line, 1973.

bushel boxes (fig. 6). Chlorinators (fig. 7) ıtrolled the level of chlorine added to the :h-pressure wash and water-dump washer as leterrent to black rot and other diseases. e chlorine in the high-pressure washer and np washer was held at approximately 150 l 50 p/m for all tests. Laboratory test data licate that this treatment should prevent ex- sive spread of black rot.

Testing in 1973 was primarily subjective :her than objective, since means for perform- : detailed quantitative evaluations utilizing k boxes were not available.

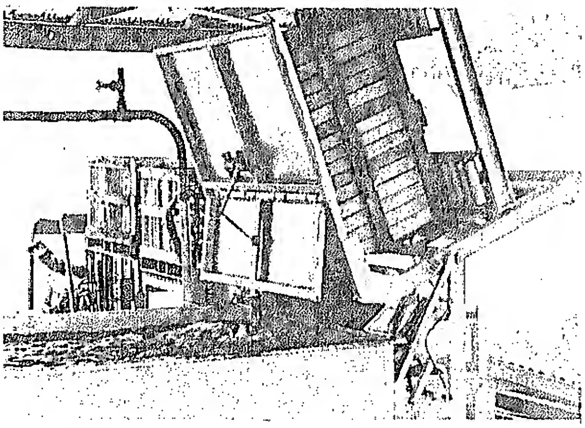

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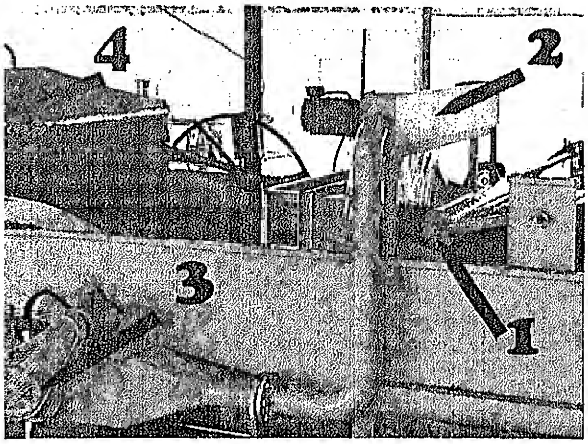
FIGURE 3.—Bulk-box dumper in use.



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URE 4.—Section of water-dump washer showing counter-balanced roller (1), cascade washer (2), pump for cascade washer (3), and high-pressure washer (4). (Height of roller controls speed of first conveyor.)

RESULTS AND DISCUSSION

Hand-washed 'Jewel' sweetpotatoes lost about 1 percent of their skin and 6 percent of their weight when put on display for 8 days (table 1). Comparable uncured roots run over the experimental grading line lost about 6 percent of their skin and about 11 percent of their weight, but roots run over the conventional grading line lost about 12 percent of their skin and 16 percent of their weight on display. Cur-

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FIGURE 5.—Machine- and hand-grading operation.

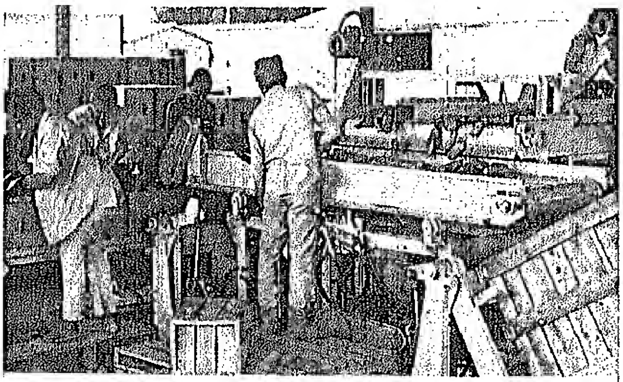

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FIGURE 6.—Reversible cross conveyor and box filler in use.

TABLE 1.—*Percentage of skin or weight loss for cured and uncured* 'Jewel' *sweetpotatoes after hand washing or running over experimental or conventional grading lines*[1]

Treatment	Estimated skin loss	Weight loss			
		Curing period[2]	First 4 days	Second 4 days	Total
Roots, uncured:					
Hand-washed	1	...	3.7	1.8	5.5
Experimental grader	6	...	7.4	3.9	11.3
Conventional grader	12	...	10.0	5.8	15.8
Roots, cured:					
Hand-washed	1	1.9	1.3	.7	3.9
Experimental grader	6	4.0	1.9	1.1	7.0
Conventional grader	12	4.5	2.0	1.1	7.6

[1] Based on 3 replicates of 8 roots each for each grading and curing treatment. Cured and uncured roots were displayed for 8 days. Weight loss is percentage of original weight.

[2] Roots cured 4 days at 85° F and high relative humidity.

ing for 4 days reduced weight losses of roots on display about 60 percent for the hand-washed roots, about 75 percent for those run over the experimental grader, and about 80 percent for those run over the conventional grader. Cured roots lost 30 to 50 percent less weight than the uncured roots when losses during curing were included.

Similar results were obtained with 'Centennial' sweetpotatoes run over the two grading lines, and the experimental grading line caused less injury than the conventional grading line and curing kept losses reasonably low, even when considerable skin was lost. Supplementary unpublished data show that relative humidity near saturation will reduce weight losses on badly skinned roots to nearly that of essentially nonskinned roots. Consequently, very high relative humidity should prove beneficial when loss of skin is increased by grading sweetpotatoes before curing and storing.

With the experimental grading line, 240 to 580 boxes of sweetpotatoes were graded per hour (table 2). When field-run sweetpotatoes were graded, 120 boxes of canning-size roots were sized out per hour, or about 25 percent of the crop. When field-graded roots were run, 10 to 37 boxes of canning-size roots were sized out per hour, or about 3 to 10 percent of the crop. Altogether, 17 to 45 percent of the crop was removed from the grading line as canners, jumbos, or pickouts. This result meant a savings in storage space of 17 to 36 percent for field-graded roots and 45 percent for the field-run roots.

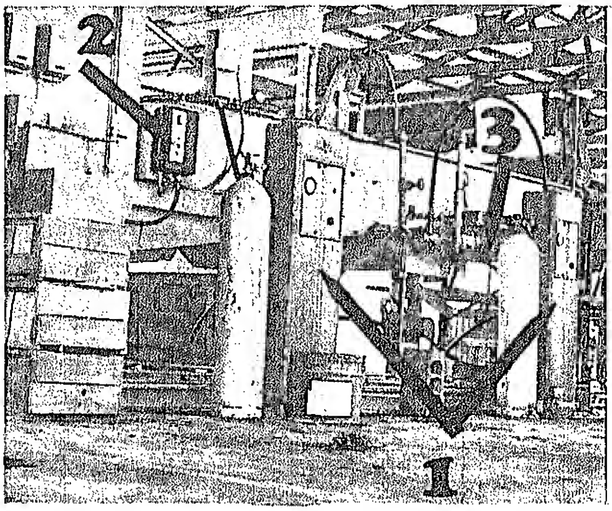

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FIGURE 7.—Side view of water-dump washer showing chlorinators (1), manual adjustment for speed of first conveyor (2), and pump for high-pressure (fresh water) washer (3).

In all eight runs, the number of canner, jumbo, and No. 2 grade roots was reduced by sizing and grading (table 3). When there were 8 to 16 jumbos per 100 roots of No. 1 size before grading, the person removing jumbos could not keep up, and about 2 to 4 jumbos were left per 100 roots of that size. For every 100 roots of No. 1 size, the sizer missed up to 3 canning-size roots except when field-run sweetpotatoes were graded; then 3 to 5 roots

TABLE 2.—*Calculated grading record for* 'Centennial' *sweetpotatoes after eight harvests in 1972*[1]

Harvest date	Boxes per hour[2] Canners	Pickouts	Jumbos	Stored[3]	Total	Pct gain[4]
Sept. 13	9.8	30.5	72.0	234.6	346.9	32
26[5]	120.0	45.0	33.0	240.0	438.0	45
Oct. 3	18.0	28.0	50.0	486.0	582.0	17
10	36.8	23.2	19.4	255.5	334.9	24
24	25.7	27.4	10.3	176.6	240.0	26
26[6]	...	...	...	...	...	...
Nov. 2	17.5	32.5	23.3	311.7	385.0	19
7	22.0	47.8	29.4	176.3	275.5	36

[1] Based on gradeout for 20 to 55 minutes of running time.

[2] Approximately 55 pounds net per box.

[3] Stored or packed in corrugated boxes and shipped; presumably U.S. No. 1 grade quality.

[4] Percentage of total not stored because of removal as canners, pickouts, and jumbos.

[5] Field run, no sorting attempted in field; all others sorted by field crew in filling boxes.

[6] Grading record incomplete.

TABLE 3.—*Number of jumbo, canner, and No. 2 grade* 'Centennial' *sweetpotatoes per 100 roots of No. 1 size as influenced by various treatments after eight harvests in 1972*

Off-grade roots	Treatment[1]	Harvest date Sept. 13	Sept. 26[2]	Oct. 3	Oct. 10	Oct. 24	Oct. 26	Nov. 2	Nov. 7	Avg
Jumbo	A	16.2	3.2	4.4	1.0	3.8	8.1	1.5	2.3	5.1
	B	2.0	.4	3.6	.8	1.4	3.6	.3	.0	1.5
	C	2.8	.5	.7	.2	1.2	1.5	.0	.1	.9
Canner	A	2.5	103.3	9.7	5.3	20.3	6.0	5.9	13.8	20.9
	B	.3	3.3	3.0	1.1	3.0	2.7	2.5	.6	2.1
	C	.5	4.6	1.9	.4	1.2	3.0	3.1	2.6	2.2
No. 2	A	3.7	9.0	5.4	13.3	24.9	6.3	13.5	28.2	13.0
	B	1.3	5.3	3.9	7.4	15.8	4.3	9.1	10.6	7.2
	C	1.3	4.4	9.5	6.0	10.0	2.6	7.5	6.8	6.0

[1] A, unwashed roots. B, roots washed, sized, and sorted. C, roots washed, sized, sorted, and treated with hot water.

[2] Field run, no sorting attempted in field; all others sorted by field crew in filling boxes.

were missed. Many of the canning-size roots not eliminated by the sizer were greater than 1⅞ inches in diameter but were too short to be No. 1's. Consequently, the sizer missed only a few roots smaller than the 1⅞-inch-diameter setting.

For every 100 roots of No. 1 size, about 4 to 28 roots were judged to be of No. 2 grade before grading. Regardless of the quantity, only about half of these roots were removed as pickouts during grading. There are two reasons why those that passed through did so. First, some were missed, especially when grading was rapid (as on October 3). Second, some roots judged by us to be of No. 2 grade were purposely left in by the workers because these roots would be tolerated by most receivers. Therefore, it appears that if more than 15,000 pounds of sweetpotatoes are to be graded per hour, more than four workers should be used to pick out off-grade roots. Furthermore, to be most profitable, a determination should be made as to which roots should be removed.

Another way of looking at the effects of

TABLE 4.—*Estimated percentages (by weight) of jumbo, canner, No. 2 and No. 1 grade* 'Centennial' *sweetpotatoes as influenced by various treatments after eight harvests in 1972*[1]

Harvest date	Treat-ment[2]	Jumbos	Canners	No. 2's	No. 1's
Sept. 13	A	32	1	2	65
	B	6	0	1	93
	C	8	0	1	91
26	A[3]	6	30	5	59
	B	1	1	5	93
	C	2	2	4	92
Oct. 3	A	11	4	4	81
	B	9	2	3	86
	C	2	1	8	89
10	A	3	2	12	83
	B	2	1	7	90
	C	1	0	6	93
24	A	8	7	17	68
	B	4	1	13	82
	C	3	1	9	87
26	A	18	2	5	75
	B	9	1	4	86
	C	4	2	2	92
Nov. 2	A	4	2	11	83
	B	1	1	8	90
	C	0	2	7	92
7	A	5	5	20	70
	B	0	0	10	90
	C	0	1	6	93

[1] Estimates based on the assumption that jumbo, canner, No. 2, and No. 1 grade sweetpotatoes weighed 1.50, 0.25, 0.50, and 0.50 pounds each for data in table 3.

[2] A, unwashed roots. B, roots washed, sized, and sorted. C, roots washed, sized, sorted, and treated with hot water.

[3] Field run, no sorting attempted in field; all others sorted by field crew in filling boxes.

grading and sizing on the quality of the stored product is by estimating the percentages (by weight) of jumbos, canners, No. 2's, and No. 1's (table 4). For field-graded roots, 65 to 83 percent were considered to be of No. 1 grade. After washing, sizing, and sorting, 87 to 93 percent of the roots were classed as No. 1 grade, i.e., increases of 9 to 26 percent were obtained. The percentage of No. 1's increased from 59 to 92 percent when field-run roots were sized and graded.

In studying the percentage changes, it should be noted that the removal of one kind of defect increases the percentage of another kind of defect in the remaining roots. Consequently, some defective roots may be removed and, on a percentage basis, produce little or no change because of the removal of other roots. This problem was avoided earlier (table 3) when the changes were shown per 100 roots of No. 1 size. Nevertheless, when jumbos, canners, or No. 2's represented 5 percent or more of the total quantity of roots before grading, they were removed to the extent that they constituted a significantly smaller proportion of the total after sizing and grading (table 4). Jumbo- and canning-size roots were usually reduced to 4 percent or less. As noted, the majority of roots that failed to qualify as No. 1 grade going into storage were those that we scored as No. 2's, and this may be partly due to the standards used.

TABLE 5.—*Percentage of weight loss for stored* 'Centennial' *sweetpotatoes as influenced by various treatments after eight harvests in 1972*[1]

Storage	Treatment[2]	Harvest date								Avg[3]
		Sept. 13	Sept. 26	Oct. 3	Oct. 10	Oct. 24	Oct. 26	Nov. 2	Nov. 7	
Commercial:										
Top pallet	A	11	21	17	9	13	9	12	12	13
	B	12	20	16	10	10	11	14	18	13
	C	12	23	20	11	10	11	16	22	15
	Cl–W	...	...	...	9	...	10	...	11	...
	Cl–H	...	...	...	...	...	11	...	11	...
Bottom pallet	A	8	13	12	7	14	14	11	11	11
	B	10	13	15	11	11	21	20	16	14
	C	12	14	13	12	15	25	20	18	16
	Cl–W	...	...	...	10	...	16	...	9	...
	Cl–H	...	...	...	...	...	17	...	8	...
Experimental	A	6	10	9	6	10	7	8	13	8
	B	5	11	9	7	10	8	8	15	8
	C	8	11	10	8	9	8	9	20	9
	Cl–W	...	...	...	8	...	10	...	7	...
	Cl–H	...	...	...	...	...	9	...	7	...

[1] Each figure is an average of 4 boxes. Weight loss is percentage of original weight.
[2] A, unwashed roots. B, roots washed, sized, and sorted. C, roots washed, sized, sorted, and treated with hot water. Cl–W, chlorine added to dump washer. Cl–H, chlorine added to hot-water tank.
[3] Does not include percentage averages for Nov. 7 harvest.

TABLE 6.—*Percentage of sound* 'Centennial' *sweetpotatoes after storage as influenced by various treatments after eight harvests in 1972*[1]

Storage	Treatment[2]	Harvest date								Avg[3]
		Sept. 13	Sept. 26	Oct. 3	Oct. 10	Oct. 24	Oct. 26	Nov. 2	Nov. 7	
Commercial:										
Top pallet	A	93	98	88	84	92	96	92	59	92
	B	95	98	86	87	89	89	85	37	90
	C	89	89	75	78	90	93	75	24	84
	Cl–W	...	...	...	82	...	91	...	54	...
	Cl–H	...	...	...	...	...	91	...	62	...
Bottom pallet	A	87	94	81	83	79	47	66	52	77
	B	82	94	69	66	64	20	19	23	59
	C	74	90	73	62	57	18	20	30	56
	Cl–W	...	...	...	64	...	47	...	60	...
	Cl–H	...	...	...	...	...	39	...	67	...
Experimental	A	85	95	80	75	90	97	89	44	87
	B	88	86	69	73	74	90	77	38	80
	C	66	79	70	64	81	90	80	30	76
	Cl–W	...	...	...	75	...	84	...	82	...
	Cl–H	...	...	...	...	...	87	...	86	...

[1] Each figure is an average of 4 boxes. Percentages based on total number of roots per treatment.
[2] A, unwashed roots. B, roots washed, sized, and sorted. C, roots washed, sized, sorted, and treated with hot water. Cl–W, chlorine added to dump washer. Cl–H, chlorine added to hot-water tank.
[3] Does not include percentage averages for Nov. 7 harvest.

TABLE 7.—*Number of sound, No. 1 grade* 'Centennial' *sweetpotatoes per 100 pounds after storage as influenced by various treatments after eight harvests in 1972*[1]

Storage	Treatment[2]	Harvest date								Avg[3]
		Sept. 13	Sept. 26	Oct. 3	Oct. 10	Oct. 24	Oct. 26	Nov. 2	Nov. 7	
Commercial:										
Top pallet	A	110	102	138	112	98	111	113	58	112
	B	141	136	113	134	105	121	115	48	124
	C	137	130	111	134	126	152	118	33	130
	Cl–W	...	...	...	116	...	137	...	69	...
	Cl–H	...	...	...	...	...	133	...	82	...
Bottom pallet	A	107	97	107	105	95	55	79	57	92
	B	120	127	98	105	80	29	27	31	84
	C	105	139	98	104	77	30	31	45	83
	Cl–W	...	...	...	90	...	67	...	81	...
	Cl–H	...	...	...	...	...	59	...	92	...
Experimental	A	82	113	106	98	106	135	108	48	107
	B	140	122	77	109	81	122	106	48	108
	C	97	110	94	111	116	136	115	40	111
	Cl–W	...	...	...	106	...	117	...	110	...
	Cl–H	...	...	...	...	...	139	...	120	...

[1] Each figure is an average of 4 boxes.
[2] A, unwashed roots. B, roots washed, sized, and sorted. C, roots washed, sized, sorted, and treated with hot water. Cl–W, chlorine added to dump washer. Cl–H, chlorine added to hot-water tank.
[3] Does not include box averages for Nov. 7 harvest.

Loss of weight during storage (curing and storage) was affected by many things, including loss of moisture from the wet roots or soil on the unwashed roots, loss of the soil itself, losses from decomposition caused by decay, and, of course, normal physiological losses. On the top pallet in commercial storage, the washed, sized, and sorted roots (treatment B) lost the same amount of weight as those not washed, sized, or sorted (treatment A), and putting the roots through the hot-water tank (treatment C) increased losses slightly (table 5). The large weight losses of roots in the top pallet (dug September 26) were due to long storage at high temperature. On the bottom pallet in commercial storage, weight losses averaged a little higher for graded roots than for ungraded roots, and the differences became particularly large late in the season when roots in this position did not keep well (table 6).

In experimental storage, weight losses were less than in commercial storage, and washing, sizing, sorting, and treating with hot water had very little effect. These results are attributed to high humidity during curing and to keeping the roots cooler (after curing) than on the top pallet in commercial storage. Chlorine had no apparent effect on weight loss except when losses from decay were reduced by the treatment (see harvest of November 7).

Excluding the November 7 harvest, 84 to 98 percent (92 percent average) of the sweetpotatoes from treatment A on the top pallet of commercial storage remained sound (table 6), and 85 to 98 percent (90 percent average) of the comparable roots from treatment B remained sound. The roots from treatment C decreased in soundness to 75 to 93 percent (84 percent average). Therefore, excluding the last harvest when none of the roots kept well, 8 percent of the roots from the top pallet failed to keep if not washed; 10 percent if washed, sized, and sorted; and 16 percent if washed, sized, sorted, and hot-water-treated. On the bottom pallet of commercial storage, the roots from all treatments did not keep as well as those in the top pallet (table 7). Poor keeping was especially noticeable after midseason with sweetpotatoes from treatments B and C. The seasonal shift in the quality of roots in the bottom pallet is illustrated in figure 8.

In experimental storage, the roots did not keep as well as on the top pallet in commercial storage. Treatment B caused more losses than

treatment A in all comparisons, and passing the roots through the hot-water tank (treatment C) did not noticeably change the result. The primary reason that the losses in experimental storage were greater than on the top pallet in commercial storage was the increase in losses from surface rot (table 8), since there was very little difference in bruised roots (table 9), end rot (table 10), Java black rot (table 11), other rots (table 12), or mouse and rat damage (table 13). The increase in surface rot in experimental storage appears to be due to additional exposure of the roots to infection associated with the delay in getting the roots from the grader to storage, because the increase occurred in all treatments and in all harvests except the last. Nielsen (*6*) demonstrated that surface rot of sweetpotatoes, after they were plowed out, increased when curing was delayed by exposure in the field. A delay of about 2 hours usually produced a significant increase.

The addition of chlorine to the dump washer on October 10 did not produce any difference in keeping regardless of where the roots were stored (table 6). On October 26, the addition of chlorine to the dump washer or to the hot-water tank did not affect keeping in the roots on the top pallet in commercial storage or in experimental storage, where all roots kept well. But on the bottom pallet in commercial storage, the roots did not keep well, and chlorine-treated roots kept considerably better than comparable

(Continued on page 16.)

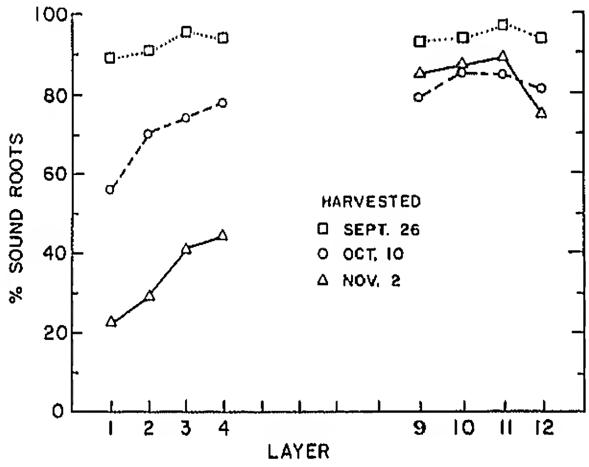

FIGURE 8.—Percentage of sound sweetpotatoes after commercial storage following early, midseason, and late harvests. (Bottom pallet, layers 1–4; top pallet, layers 9–12.)

TABLE 8.—*Percentage of* 'Centennial' *sweetpotatoes with surface rot after storage as influenced by various treatments after eight harvests in 1972*[1]

Storage	Treatment[2]	Harvest date								Avg
		Sept. 13	Sept. 26	Oct. 3	Oct. 10	Oct. 24	Oct. 26	Nov. 2	Nov. 7	
Commercial:										
Top pallet	A	2.5	0.0	4.2	7.4	1.8	1.3	1.7	13.4	4.0
	B	.9	.4	4.5	5.8	3.8	6.7	4.4	16.5	5.4
	C	3.5	4.0	5.8	11.7	2.8	3.3	8.8	11.6	6.4
	Cl–W	...	...	...	12.3	...	4.3	...	12.9	...
	Cl–H	...	...	...	...	...	1.6	...	16.7	...
Bottom pallet	A	4.5	1.0	6.1	10.7	8.0	18.1	16.8	8.7	9.2
	B	8.9	.7	8.3	19.7	18.3	16.9	22.5	11.4	13.3
	C	7.4	2.5	12.4	18.5	14.4	19.7	25.7	11.0	14.0
	Cl–W	...	...	...	15.5	...	10.8	...	11.8	...
	Cl–H	...	...	...	...	...	16.2	...	14.9	...
Experimental	A	6.3	4.7	12.9	13.5	6.9	2.6	9.5	4.4	7.6
	B	7.8	11.4	21.4	16.2	20.5	7.4	19.6	5.4	13.7
	C	19.1	13.4	23.7	22.6	14.6	10.0	16.8	7.9	16.0
	Cl–W	...	...	...	14.0	...	11.7	...	3.8	...
	Cl–H	...	...	...	...	...	6.5	...	2.6	...

[1] Most of decay was typical of surface rot caused by *Fusarium oxysporum* Schlect. Each figure is an average of 4 boxes. Percentages based on total number of roots per treatment.

[2] A, unwashed roots. B, roots washed, sized, and sorted. C, roots washed, sized, sorted, and treated with hot water. Cl–W, chlorine added to dump washer. Cl–H, chlorine added to hot-water tank.

TABLE 9.—*Percentage of* 'Centennial' *sweetpotatoes with unsightly bruises after storage as influenced by various treatments after eight harvests in 1972*[1]

Storage	Treatment[2]	Harvest date								Avg
		Sept. 13	Sept. 26	Oct. 3	Oct. 10	Oct. 24	Oct. 26	Nov. 2	Nov. 7	
Commercial:										
Top pallet	A	1.6	0.5	2.8	5.1	0.5	0.0	0.5	3.4	1.8
	B	2.3	.0	4.5	2.3	3.6	2.2	3.0	3.6	2.7
	C	6.3	.0	2.6	4.3	5.1	2.1	2.7	11.0	4.3
	Cl–W	...	...	...	3.1	...	2.3	...	16.3	...
	Cl–H	...	...	...	...	...	1.4	...	10.3	...
Bottom pallet	A	6.4	.0	.0	2.9	.0	1.5	6.2	3.5	2.6
	B	7.2	.0	1.3	4.8	6.4	.7	8.9	6.4	4.5
	C	15.4	.0	2.1	7.5	8.3	.8	9.7	11.3	6.9
	Cl–W	...	...	...	4.8	...	3.5	...	12.3	...
	Cl–H	...	...	...	...	...	2.4	...	9.0	...
Experimental	A	4.3	.0	.8	6.4	.0	.0	.0	4.8	2.0
	B	2.2	.7	.5	4.8	2.2	1.0	.7	5.1	2.2
	C	7.4	1.0	.3	4.5	3.6	1.5	.7	4.0	2.9
	Cl–W	...	...	...	1.8	...	1.4	...	6.8	...
	Cl–H	...	...	...	...	...	2.2	...	7.3	...

[1] Each figure is an average of 4 boxes. Percentages based on total number of roots per treatment.
[2] A, unwashed roots. B, roots washed, sized, and sorted. C, roots washed, sized, sorted, and treated with hot water. Cl–W, chlorine added to dump washer. Cl–H, chlorine added to hot-water tank.

TABLE 10.—*Percentage of* 'Centennial' *sweetpotatoes with end rot after storage as influenced by various treatments after eight harvests in 1972*[1]

Storage	Treatment[2]	Harvest date								Avg
		Sept. 13	Sept. 26	Oct. 3	Oct. 10	Oct. 24	Oct. 26	Nov. 2	Nov. 7	
Commercial:										
Top pallet	A	1.6	0.0	1.4	1.8	1.7	1.3	0.3	2.0	1.3
	B	.3	.0	.0	.3	.4	.4	.8	4.1	.8
	C	.3	.5	2.5	2.4	1.1	1.4	.9	3.6	1.6
	Cl–W	...	...	...	.3	...	1.4	...	4.2	...
	Cl–H	...	...	...	...	...	2.0	...	5.4	...
Bottom pallet	A	.7	.0	5.6	2.7	6.7	30.0	9.7	2.5	7.2
	B	1.4	.0	6.6	1.5	4.5	52.0	36.4	5.6	13.5
	C	2.5	1.0	3.8	4.9	11.5	43.5	33.2	7.3	13.5
	Cl–W	...	...	...	3.5	...	31.7	...	3.5	...
	Cl–H	...	...	...	...	...	35.2	...	5.9	...
Experimental	A	2.6	.4	.6	.4	.0	.4	.5	.0	.6
	B	.9	.0	1.9	2.4	2.1	1.5	2.1	.4	1.4
	C	4.7	1.8	1.0	3.3	.3	1.5	.7	.3	1.7
	Cl–W	...	...	...	2.5	...	2.0	...	.4	...
	Cl–H	...	...	...	...	...	3.7	...	1.3	...

[1] Decay at one or both ends of a root was scored as end rot, so data are not limited to decay caused by *Fusarium* sp. usually associated with end rot. Each figure is an average of 4 boxes. Percentages based on total number of roots per treatment.
[2] A, unwashed roots. B, roots washed, sized, and sorted. C, roots washed, sized, sorted, and treated with hot water. Cl–W, chlorine added to dump washer. Cl–H, chlorine added to hot-water tank.

TABLE 11.—*Percentage of* 'Centennial' *sweetpotatoes with Java black rot after storage as influenced by various treatments after eight harvests in 1972*[1]

Storage	Treatment[2]	Harvest date								Avg
		Sept. 13	Sept. 26	Oct. 3	Oct. 10	Oct. 24	Oct. 26	Nov. 2	Nov. 7	
Commercial:										
Top pallet	A	0.8	1.6	1.4	1.0	0.5	0.4	0.0	20.3	3.3
	B	.7	.4	3.9	3.0	.0	.0	.0	32.0	5.0
	C	.0	1.5	7.0	2.6	.0	.0	.0	47.3	7.3
	Cl–W	...	...	...	2.4	...	.0	...	1.9	...
	Cl–H	...	...	...	...	...	.0	...	2.0	...
Bottom pallet	A	1.1	.0	.0	.0	.0	.0	.0	23.8	3.1
	B	.7	.0	.0	1.8	.0	.0	1.1	30.5	4.3
	C	.3	.0	.3	.6	.4	.0	.0	24.4	3.3
	Cl–W	...	...	...	1.0	...	.0	...	.5	...
	Cl–H	...	...	...	...	...	...	...	1.7	...
Experimental	A	1.4	.0	.3	2.8	.0	.0	.0	40.5	5.6
	B	.6	.0	.0	1.8	.0	.0	.0	49.2	6.5
	C	2.2	.3	.0	2.7	.0	.0	1.6	56.4	7.9
	Cl–W	...	...	...	4.7	...	.0	...	6.9	...
	Cl–H	...	...	...	...	...	.0	...	.0	...

[1] Most of decay was typical of Java black rot, *Diplodia tubericola* (Ell. & Ev.) Taub., but some charcoal rot, *Sclerotium bataticola* Taub., may have been present. Each figure is an average of 4 boxes. Percentages based on total number of roots per treatment.

[2] A, unwashed roots. B, roots washed, sized, and sorted. C, roots washed, sized, sorted, and treated with hot water. Cl–W, chlorine added to dump washer. Cl–H, chlorine added to hot-water tank.

TABLE 12.—*Percentage of* 'Centennial' *sweetpotatoes with other rots after storage as influenced by various treatments after eight harvests in 1972*[1]

Storage	Treatment[2]	Harvest date								Avg
		Sept. 13	Sept. 26	Oct. 3	Oct. 10	Oct. 24	Oct. 26	Nov. 2	Nov. 7	
Commercial:										
Top pallet	A	0.0	0.4	2.0	0.3	1.7	0.0	3.1	1.9	1.2
	B	.7	.4	.8	1.9	2.0	.3	2.6	2.7	1.4
	C	.6	.5	5.7	.0	.3	.0	3.6	1.0	1.5
	Cl–W	...	...	...	.4	...	.3	...	1.1	...
	Cl–H	...	...	...	...	...	1.0	...	.0	...
Bottom pallet	A	.0	.9	5.4	.4	5.2	1.5	1.7	8.1	2.9
	B	.0	.0	6.3	3.2	2.4	.4	8.2	10.1	3.8
	C	.0	.4	5.0	2.9	3.6	3.9	4.1	6.5	3.3
	Cl–W	...	...	...	3.5	...	1.7	...	6.0	...
	Cl–H	...	...	...	...	...	.9	...	.4	...
Experimental	A	.5	.0	5.3	1.1	3.4	.5	1.5	3.2	1.9
	B	.5	.3	6.9	1.3	1.8	.0	.4	1.2	1.6
	C	.3	.0	4.3	2.4	.7	.0	.7	.7	1.1
	Cl–W	...	...	...	2.2	...	.7	...	.4	
	Cl–H	...	...							

[1] Includes decaying roots not included under end re
tatively identified as dry rot, *Diaporthe batatis* Harter
ex Fr.) Lind. Each figure is an average of 4 boxes. P

[2] A, unwashed roots. B, roots washed, sized, and sort
Cl–W, chlorine added to dump washer. Cl–H, chlorine

TABLE 13.—*Percentage of stored* 'Centennial' *sweetpotatoes damaged by mice or rats as influenced by various treatments after eight harvests in 1972*[1]

Storage	Treatment[2]	Harvest date								Avg
		Sept. 13	Sept. 26	Oct. 3	Oct. 10	Oct. 24	Oct. 26	Nov. 2	Nov. 7	
Commercial:										
Top pallet	A	0.9	0.0	0.0	0.3	2.5	0.4	2.7	0.5	0.9
	B	.0	1.1	.8	.0	1.1	1.2	4.1	3.6	1.5
	C	.0	2.3	1.9	.8	.7	.3	9.1	1.4	2.1
	Cl–W	...	...	...	.0	...	.7	...	10.1	...
	Cl–H	...	...	...	...	...	3.0	...	3.3	...
Bottom pallet	A	.0	3.9	2.3	.7	1.2	2.2	.0	1.5	1.5
	B	.0	5.2	8.8	3.3	4.3	10.2	3.7	13.3	6.1
	C	.0	5.8	3.8	4.1	5.4	14.6	7.9	10.0	6.5
	Cl–W	...	...	...	7.4	...	5.6	...	6.9	...
	Cl–H	...	...	...	...	...	6.2	...	1.0	...
Experimental	A	.0	.0	.0	1.1	.0	.0	.0	3.3	.6
	B	.3	1.6	.4	.3	.0	.0	.0	.4	.4
	C	.0	4.2	.4	.0	.0	.0	.0	.6	.7
	Cl–W	...	...	...	.0	...	.0	...	.4	...
	Cl–H	...	...	...	...	...	.0	...	1.6	...

[1] Roots damaged by mice or rats were usually decayed, but decaying roots with such rodent damage were not classed under decay or rot. Each figure is an average of 4 boxes. Percentages based on total number of roots per treatment.

[2] A, unwashed roots. B, roots washed, sized, and sorted. C, roots washed, sized, sorted, and treated with hot water. Cl–W, chlorine added to dump washer. Cl–H, chlorine added to hot-water tank.

untreated roots. On November 7, the addition of chlorine to the dump washer or to the hot-water tank improved keeping of all stored roots, especially those in experimental storage where a good cure occurred.

The reduction in losses effected by chlorine treatment was associated with a reduction in end rot (table 10) and possibly surface rot (table 8) following the harvest of October 26 and a reduction in Java black rot (table 11) following the harvest of November 7. These effects of chlorine need verification before they can be relied upon. Chlorine-treated roots appeared lighter or brighter in color for several days after treatment. The difference in treated and untreated roots was not great and disappeared during storage. Whether this bleaching effect is desirable or undesirable is not clear.

For every 100 pounds of roots placed on the top pallet in commercial storage, washing, sizing, and sorting increased the number of No. 1 grade roots recoverable after storage from 112 (treatment A) to 124 (treatment B) or 130 (treatment C) on the average (excluding harvest of November 7 (table 7)). In five of the seven remaining harvests, the increase in recoverable roots amounted to 20 to 25 percent (see harvests of September 13, 26; October 10, 24, and 26). Following the harvest of November 2, the increase was about 5 percent, and following the harvest of October 3, there was a decrease of about 15 percent. On the bottom pallet in commercial storage, washing, sizing, and sorting (treatments B and C) did not cause much of a change in the number of sound roots recoverable through the first four harvests, but thereafter, considerably fewer roots were recovered from this position.

In experimental storage, there was essentially no difference attributable to treatment in the number of No. 1's recoverable after storage for each 100 pounds of roots stored. This result was due to the increase in losses caused by surface rot when the roots were washed, sized, and sorted as noted above (see table 8).

The importance of this kind of comparison cannot be overemphasized because the primary purpose of washing, sizing, and sorting before storage is to place fewer jumbos, canners, and No. 2's in storage and to place more No. 1's there. If losses of No. 1's are increased by washing, sizing, and sorting, these losses may offset the gains realized through increased ef-

ficiency in harvesting, through increased efficiency and accuracy in sizing and sorting, and through the options open for disposition of all sizes and grades. The quantity of No. 1's that may be lost because of washing, sizing, and sorting at harvest without overcoming the advantages is unknown and probably differs for different farm-harvest marketing organizations. Each organization manager will need to decide what values to place on the data presented and to consider the many intangibles inherent in the overall system. The data collected indicate that there could be a benefit from washing, sizing, and sorting before storage if sweetpotatoes are free of black rot and are harvested, graded, and placed under good-to-excellent curing and storage conditions with minimum exposure or desiccation (or both) in the field or at the grading shed.

No black rot was present in sweetpotatoes from treatments A or B during the 2 years that tests were made with the experimental grading line. Accordingly, no need was demonstrated for the hot-water tank. We believe it is unsafe to assume that this will always be the case. Some provision for handling a crop from a field where black rot is present should be available. Because of the low risk of black rot contamination and the trouble and cost of obtaining and operating a hot-water-treatment tank, consideration was given in subsequent work to chlorine as an alternative method of combating this disease.

We associate the increase in losses following the hot-water treatment with additional injury to roots in going through the treating tank and not with their exposure to water at 125° F for 2 to 2½ minutes. Data from supplementary tests with 'Jewel' and 'Centennial' sweetpotatoes show no reduction in keeping or sprouting following treatments at 120° or 125° F for up to 10 minutes or at 130° F for up to 6 minutes.

The additional injuries to roots during washing, sizing, sorting, or treatment with hot water usually healed well and did not detract noticeably from the appearance of the roots if curing conditions were good. Although such injuries did not "detract noticeably," that is not to say that the injuries did not detract some, but an accurate evaluation of this was not made.

On a few occasions, sufficient extra roots from the experimental grading line (treatment C) that were placed in commercial storage for evaluation were removed from storage and run over the conventional grading line in preparation for shipment to market. The rate of grading approximately doubled because workers had very little to sort out after the roots had been run over the experimental grading line at harvest. Workers also reported that the roots washed at harvest were brighter and more attractive than those not washed.

One of the unexpected results was that mice and rats could distinguish between washed and unwashed roots. On the bottom pallet in commercial storage, mice and rats caused two to three times more damage to washed roots than to unwashed roots (table 13). On the top pallet, about twice as much damage was done to washed roots. If the difference in damage caused by these rodents were added to the sound roots, the differences in keeping between washed and unwashed roots would be reduced some but not enough to invalidate the comparisons made above.

A preliminary test was conducted to demonstrate the feasibility of running sweetpotatoes over the experimental grading line, putting the roots in corrugated boxes, palletizing the boxes, and curing the roots for 4 days before shipping them to market. These roots, when compared with freshly dug roots from the same field, tasted better when baked and tended to lose less weight while on display. Additional work is needed to verify that a 4-day cure immediately after washing, sizing, and sorting will provide better culinary quality and shelf life in the market.

The 1973 commercial grading line has a capacity of about 500 bu/h on the average, and peak rates are sometimes considerably higher. The sweetpotatoes were cleaned satisfactorily with high-pressure spray (110–120 lb/in^2) from 17 stainless-steel nozzles rated at 1.5 gal/min and 150 lb/in^2. Overall, this grading line caused about half as much damage to the roots as the conventional grading line, indicating that the 1972 and 1973 grading lines were approximately equal in gentleness. Again, no black rot was present, so the commercial effectiveness of chlorine as a deterrent to the spread of this organism could not be verified.

In using the 1973 grading line it became evident that sorting sweetpotatoes before curing and storing is very advantageous if some of

the roots are visibly damaged by cold or wet soil conditions. The damaged roots could be removed from the box where they might cause decay of adjacent roots. It is also evident that the procedure and equipment described in this report could benefit both large grower-shippers and small growers who sell to shippers at harvest. All the sweetpotatoes would be graded at the time of sale and both seller and buyer would know the actual packout percentage, so sampling and estimating packout would not be necessary.

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